UNDER-SEA FIGHTER

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"Submarine sinks ship in the St. Lawrence River." Headlines such as this have brought the submarine, as a means of destruction, back into the public eye once again. The first World War was the real testing period for the submarine and, much to our discomfort, proved it to be a valuable and formidable weapon of war.

The history of the submarine dates from 1620, when Cornelius van Drebel, a Dutchman in the services of King James I of England, built such a vessel, which is said to have been driven by twelve oarsmen at a depth of 12 to 15 feet for several hours in the Thames. In 1888, the United States Navy Department invited submarine designs; that of John P. Holland was selected. After many revisions of the original design his submarine was purchased by the government in 1900, the British Admiralty ordered five of the same type from Messrs. Vickers.

The construction of the submarine incorporates many different operations, and in some cases there are entirely different designs for the various sized underwater craft. In hull construction, there are principally two types, either single or double hull. The first type is a submarine having a strong hull of circular sections, but these sections change to elliptical sections at the extremities. The main ballast tanks are at the bottom of the circles. The second type or double hull has a strong hull of almost circular section, the pressure hull, which is enclosed by an outer hull of light construction. The space between the two hulls contains the tanks. In addition to seaworthiness, a better shape for surface propulsion can be given the hull and increased speed obtained. The single hull type has the advantage of more rapid submergence, the tanks being smaller and well below the surface water plane. Generally, the single hull type of construction is now limited to the smallest underwater craft, the double to the largest. In the medium size a partial double hull is adopted, the outer hull enclosing the pressure hull over a portion of its extent only.

The "superstructure" is the light structure fitted above the pressure or external hull. This light structure is fitted with a deck, and is raised in height amidship to form a navigating bridge, which is reached from the control room through the conning tower built up from the pressure hull. The conning tower is fitted with hatches at the bottom and at the bridge level, and being the last portion of the pressure hull to submerge is frequently constructed of thick plating to resist projectiles. The conning tower forms a base for the vertical brackets which support the periscope.

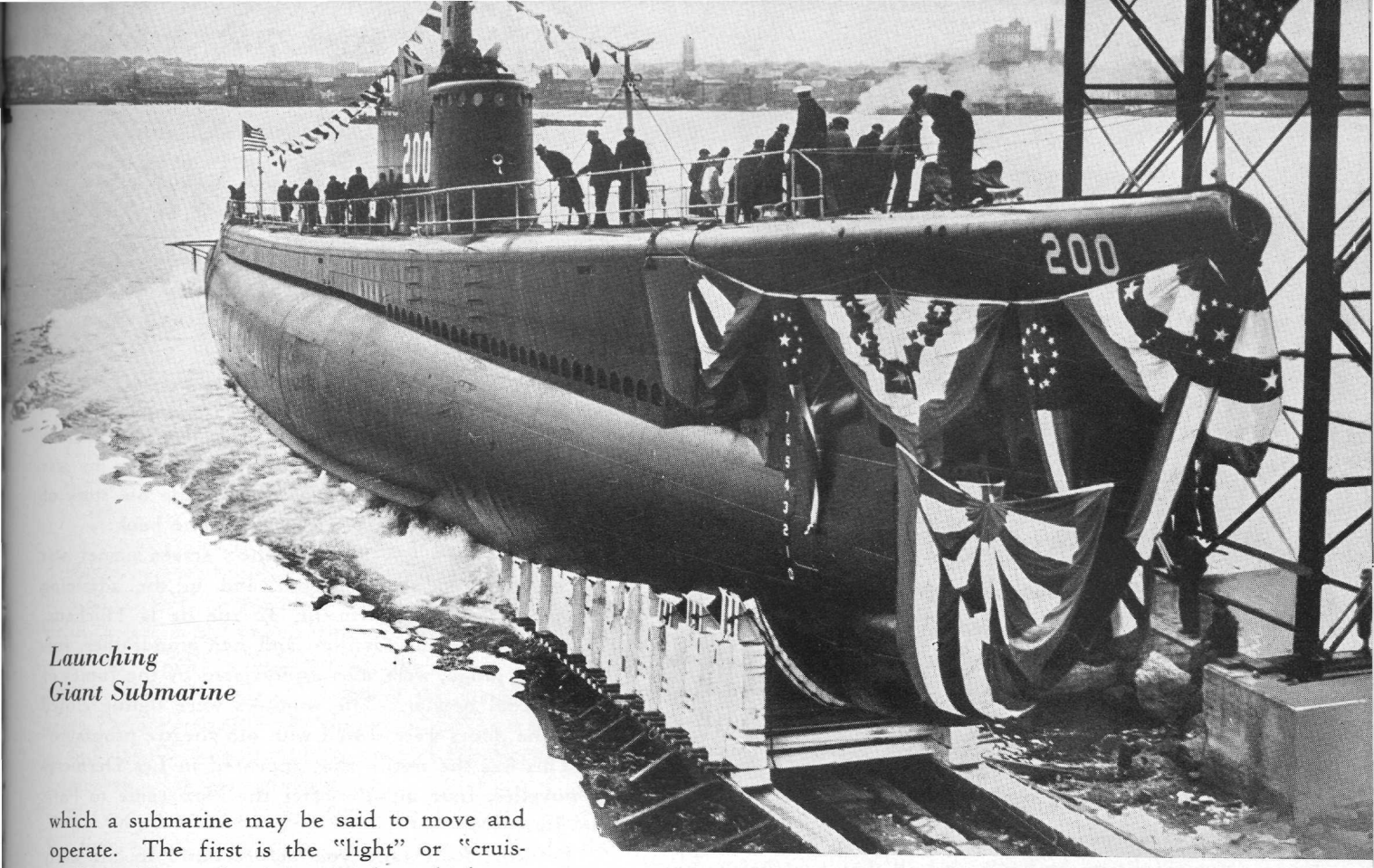
Contained inside of the submarine are various tanks, of which the most important are the "main ballast tanks." It is by filling these tanks with sea water that the submarine is submerged. Each tank has a valve at the bottom for the entry or exit of water, a vent valve at the top for the escape of air, and a pipe through which compressed air enters the tank and forces out the water. Some tanks are also fitted with drain pipes for emptying them by pumping. There are also tanks containing compressed air for the firing of torpedoes and also for breathing when the submarine is under water.

The power needed for the propulsion of the submarine on the surface is furnished by a Diesel engine of specific type. Those installed in the 1,000 to 1,800 ton class submarine develop 17 to 20 knots, while those of the 3,000 ton class develop 22 to 23 knots. But the 3,000 ton craft is too large for ordinary purposes; most underwater craft are of the lighter type. When submerged, the submarine is propelled by electric motors run from batteries which are charged by the Diesel engine when on the surface.

The eyes of the submarine when it is submerged are the periscope. It is a tube about 20 feet long containing prism sand lenses, and extends from a point within the conning tower, through the roof of the latter. It may contain as many as seventeen optical implements.

Except for tanks essential for their operation, earlier submarines had little or no water-tight subdivisions. In the later types the hull is subdivided to the maximum extent, experience having proved the value of this fixture in case of an accident. Starting from the forward end, the main compartments in order are: the fore torpedo room, the battery space, the control room, the engine room, the motor room, and the stern torpedo room.

There are three broadly distinctive conditions under



Launching Giant Submarine

which a submarine may be said to move and operate. The first is the "light" or "cruising" condition, where she stands as high out of the water as is possible. The whole of her ballast tanks are empty. The second condition is the "awash." In this instance only those ballast tanks which are kept full when running submerged are in the empty state. This condition may almost be described as a secondary phrase of "running light," because the vessel is only a little lower in the water.

The third condition is "submerged," which is the stage when the vessel is running completely under-water.

Only a few minutes are required to pass from "cruising" to the "submerged" condition, the rapidity of the change depending upon how quickly the deck hamper is removed and stored within the vessel. The conning tower hatch is then closed and made fast and watertight from within the vessel, while any other openings in the hull are closed and sealed by means of valves controlled by handles.

When all is completely sealed, the water is allowed to pour into the one or more of the large ballast tanks in order to destroy the greater part of the vessel's capacity to float. Gages are watched closely as this operation proceeds, so that just the correct volume of water and no more may be admitted. Some water is then allowed to enter the fore and aft tanks in order to bring the boat on an even keel. The tanks in the center of the boat are then carefully flooded so as to reduce the buoyance to a few hundred pounds. The boat being at rest, the effect of flooding the tanks is to lower her into the water until only the top of the conning tower protrudes above the waves. Everything is then ready for disappearing under the water. The electric motors are started, and under the propulsion of the screws, the boat moves forward. In doing so the resistance offered by the water and bearing upon the deck and hydro-plane, which are horizontal rudders, forces the vessel downwards into the sea. All steering operations in the horizontal plane are effected by means of an ordinary rudder at the stern such as is carried by surface vessels. Steering in the vertical plane is carried out by horizontal planes. The man at the wheel has complete control over the vessel, and can keep his vessel running satisfactorily by reading the gages.

To return to the surface once again the vessel is first brought close to the surface. Then compressed air is used to force enough water out of the ballast tanks so that the boat may come to the surface. Once it is on the surface the Diesel engine is again started and when the hatch is opened the remaining water is cleared out by blowers. The submarine is steered by its rudder when on the surface just like any other surface craft.

The goal towards which all engineers are striving is the perfection of a submarine having a higher surface speed, an economical cruising radius of more than 10,000 miles, a submerged speed of at least 25 knots and a far more formidable armament than that borne today. To insure the fulfillment of these specifications within a reasonable space of time, some sensational discovery or startling new development is imperative. The dual system of propulsion must be replaced; at

(Continued on Page 24)

UNDER-SEA FIGHTER

(Continued from Page 11)

any rate, electrical propulsion underwater should be improved or replaced by a new method of propulsion. Up to date, engineers have found that with an increase in efficiency the tonnage also must be increased, thus most submarines approaching the above developments are too large for ordinary naval purposes. But as long as there is a "will", there is a "way;" in the future we can expect some radical revolutions in submarine construction and design.

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